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AUTHOR Maley, Donald
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ABSTRACT

A rationale for teaching the heritage of technology points out that technology has been used to alter the environment, social institutions, and civilizations, and has a profound effect on human living. An outline for a curriculum in technical heritage shows that it should be taught with respect to three periods--the past, the present, and the future. The heritage of technology related to the past would deal with the present impact of technological developments from a prior period, stressing the evolution of technological developments in a variety of areas. The major unit topics of such a course would be the contribution to the growth of civilization of the development of tools and machines, power and energy, and communications and transportation. A course on the heritage of technology as it relates to the present would involve studies regarding current technology and its future impact. Studies in the design of the future would explore possible beneficial developments based on knowledge of the purposes and uses of technology. An instructional design is presented for each of these projected courses. (JD)

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TEACHING THE HERITAGE OF TECHNOLOGY
PAST, PRESENT, AND FUTURE

BY

DONALD MALEY
PROFESSOR AND CHAIRMAN
INDUSTRIAL EDUCATION DEPARTMENT
UNIVERSITY OF MARYLAND
COLLEGE PARK, MARYLAND

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TEACHING THE HERITAGE OF TECHNOLOGY

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Donald Maley
Professor and Chairman
Industrial Education Department
University of Maryland
College Park, Maryland

Teaching the heritage of technology is, in many respects, teaching the legacy of civilization itself. The constructions and material accomplishments of the early Egyptian and Babylonian cultures are but part of the scenario that links man's most primitive innovations to Neil Armstrong's footprint on the moon. The Colossus of Rhodes, the Acropolis of Athens, and the Pyramids of ancient Egypt are the legacy of prior civilizations whose wondrous works were products of a technology that is obscured by the magnificence of the product. Yet their very existence forces the mind to revel in the ingenuity and effectiveness of the technology that made such things possible. To be ignorant of the heritage of technology is to be illiterate of the means by which man has moved from the cave to the skyscraper, from the stone axe to the modern production complexes, and from the wooden hoe or digging stick to the present supermarket.

The heritage of technology is its dominance in the history of human existence down the long road of time. It has taken the human from a position of complete dependency on the environment to the present where mankind has demonstrated a capability for transforming the environment to meet his needs. Technology has been the instrument of change and progress as well as dis-

ruption and destruction. Created out of the genius of humankind, the evolving technology has become a dominant factor in practically all areas of man's existence. The arts of music, medicine, communication, construction, production, distribution, transportation, and commerce are tangible evidence or expressions of the human's ability to devise, produce, and use technology.

The heritage of technology is in a sense the heritage of human ingenuity translated into works of an ever-increasing sophistication that reaches beyond the comprehension of most individuals. It was the extension of human capability through technology in its earliest form that started the long and evolving process that transformed humankind from a creature of fragile existence in a hostile environment to the present form of civilization and environmental accommodation. The long trail of human transformation on this planet has progressively evolved into a higher state of human condition as a result of the advancements in technology that became the instruments of change and challenge.

As Sherwood L. Washburn (1962) put it, . . . it was the success of the simplest tools that started the whole trend of human evolution and led to the civilizations of today. (p. 13)

What is the heritage of technology?

There is no simple answer to that question. The heritage of technology is the standard of living experienced by the peoples of this earth, whether that be with the primitive cultures of New Guinea, the cultures of the inner city, or the life of the Kansas farmer. Technology exists in varying states of development in all societies. It is many times the difference between starvation and opulence, between walking and riding, between the scratch plow and the gang plows of the corn belt, and the difference between the

crackling fire and living conditions of Lincoln's cabin and the comfort and well appointed living rooms of most Americans today.

Spier (1969) defined technology as the means by which man controls or modifies his natural environment. (p. 131) Thus, one might generalize that the heritage of technology is the accumulated changes that the human has brought about in the natural and man-made environment.

The heritage of technology is not just a matter of looking back into the history of the human race for its contributions and evolution. The use that contemporary humankind makes of the technology will certainly define the heritage of technology for those who will live in the 21st century. The same may be said about future generations and their use of technology for they, too, will leave a legacy of technological impacts. Each generation produces its own heritage with respect to the impact of technology in that time and its consequent implication for future generations. Thus, when one realistically examines the heritage of technology, it is in reality a study related to the heritage from the past, the heritage that the present technology will bestow on the next generation, and the technological heritage that future generations will bestow on those who follow.

The profound importance of the technological heritage phenomena becomes more apparent as one examines the ways that technology may be used to alter the environment, to alter social institutions, and perhaps to alter man himself. The control of technology is clearly in the hands of humankind, but control must be based on understanding. Thus the teaching of the heritage of technology, past, present and future becomes an imperative if we are to understand how we got here, the nature of the impact of present-day technological decisions on tomorrow, and the relevance of tomorrow's technological

decisions on the future of the human race. The key to human prosperity in a technological society is a disciplined responsibility that is tempered and guided by understanding.

Why teach the heritage of technology?

To teach the heritage of technology is to teach the endowment of past generations from the cave dweller to the spacemen of today. It is to teach that which mankind in his higher mental processes has been able to fashion and improve upon from the beginning of time.

The following are some school program or education related reasons for teaching the heritage of technology.

1. It is the study of the principal change agent in most societies.
2. It is the study of how the present generation got to where it is today in all of its physical and material accommodations.
3. The study of the heritage of technology may well be the study of that which will sustain life and contribute to human existence in a world that doubles its population every 37 years.
4. The future is dependent upon the use of technology in the present. Thus, a technologically literate society may help guide the processes by which that future is shaped.
5. A democracy in an era so profoundly affected and influenced by technology depends upon an informed citizenry regarding the nature and significance of technology as a prerequisite for effective decision making.
6. To be illiterate of the heritage of technology in the present and future societies is analogous to walking through a forest without recognizing or understanding any of the plants, trees, flora or fauna -- to say nothing about how one might use these items to

sustain life and prosper.

7. The study of the heritage of technology is in many respects the study of the means by which the human intellect gets translated into the materialism of books, music, art, engineering wonders, space walks, and television from the outer reaches of space.
8. The study of the heritage of technology can provide the basis on which a continuity to history may be established. Roger Burlingame (1959) stressed this point in his discussion of "The Hardware of Culture".

. . . . The Carthaginian wars, the fall of the Roman Empire, the Norman invasion, the Magna Carta, the discovery of America, the War of the Roses, the Spanish Inquisition, the French Revolution, the Louisiana Purchase, the Missouri Compromise were words with dates attached, loosely strung together by such terms and phrases as "the rise and fall of civilization," "the struggle for liberty," "Renaissance," "Reformation," "Enlightenment" -- abstractions cooked up out of hindsight to give "dignity" to the record.

It was only when I discovered from the exploration of rare or forgotten writings and artifacts that the vast gulfs between these events were filled with galleys and sailing ships, roads, wagons, mines, canals, magnetic compasses, catapults, crossbows, cannons, water wheels, muskets, machine tools, and dynamos that I began to see a real continuity and integrity to history. (p. 15)

9. The study of the heritage of technology is merited simply because of its enormous importance to the maintenance and growth of civilized mankind on an earth with finite resources. The proper use of technology and its further development may actually be the thread by which the fabric of human existence can be held together.

What to study regarding the heritage of technology -- past, present and future.

There is no single answer to this concern. It is, however, one that deserves our fullest attention. The most beneficial interests of society

should be a central focus in such a deliberation. The heart of this issue is -- "what should the content of the heritage of technology be for all of the citizens in a free and democratic society?" This point centers around the general education requirement for intelligent decision-making in a society governed by the democratic ideal.

Decision-making in the context of a democratic society, and as a function related to the general education component, is integrally tied to a variety of involvements with technology in the course of daily living in a free society so dependent on technology for its existence. Such involvements include --

- the user role, involving the safe and effective use of materials, tools, machines, household items, and the means of recreation.
- the consumer role, as related to the purchasing and decisionmaking related to homes, appliances, cars, entertainment media, furniture, boats, clothing and food.
- the producer role, involving the tools, materials and machinery of agriculture, manufacture, commerce, and service.
- the voter or decision-maker role, involving how to choose between alternatives in community development, energy forms, transportation modes, trash and waste disposal, housing, communications systems, resource development, production processes, etc.

The options available to contemporary persons in these United States are more abundant and more far-reaching than was the case of the earlier civilizations. This increase in options is a direct heritage of an advanced technology in a free society.

It is also important to recognize that beyond the general education

study of technology, the engineer, technician, scientist and historian will certainly deal in greater depth in areas of specialization related to their particular focus or interests. Some will deal with the principles, theories, and scientific dimensions while others will devote their energies to the production of products, structures, equipment, goods, and services.

The study of technology has taken on many different forms in the various educational institutions. Some of these studies have included:

- In depth study of technological areas such as transportation, communications, machines, and tools.
- Taxinomical studies of technological areas.
- Historical studies of technology.

The confinement of the study of technology to a narrow field or area with a considerable penetration may be a matter of individual choice. However, that which is purported to be of value to most individuals in the society must be more of a form of general technology that would enable the individual to deal with it in a non-threatening and literate mode of involvement.

The heritage of technology can be taught with respect to three periods in the continuum -- past, present, and future as previously identified.

Past
Heritage

1. The heritage of technology related to the past would deal with the present impact of technological developments from a prior period. This would stress the evolution of technological developments in a variety of areas and their impact on the present.

Present
Heritage

2. The heritage of technology related to the present would deal with the impact of current, present-day technological developments, and their implications on the future. This would stress the current use of technology and its consequences on the future. This could

be with respect to the quality of life, environment, energy sources, water availability, and numerous other factors whose quality and quantity in the future may depend on present uses of technology.

This point introduces a new but pressing issue that must be a part of any study of the use of technology in a given period. That factor is a concern for the future and future generations of mankind. The shaping of tomorrow or the future began yesterday -- one, two, five hundred, or thousands of years ago. That is what one might call the historical antecedent of tomorrow. It is an accomplished fact, with which present-day society may do little about. On the other hand, mankind can do something about current technology and the manner in which it is used. In this regard, the present-day society can, by its wisdom or lack of wisdom, define to a degree the nature of the future in so many ways. The future, in regard to what present humans can control, is defined by what the human element chooses to do today.

Furthermore, mankind has, through his technology, arrived at the point where he can in a large measure design the kind of a future he so desires. It is this present-design of the future which will define the heritage of technology for the future, for that heritage and legacy is in the process of being formulated today.

3. The heritage of technology with respect to the future is not so clear as the past or present. But just as every generation of people has had their heritage, so too, will the societies of the future have their legacy to bestow on their offspring and future generations. The relevance of the heritage of technology in the

Future
Heritage

future will be substantially increased and perhaps have greater impact due to the ever-increasing need for technology to provide the essential ingredients for human survival and human well being.

Studying the heritage of technology -- past.

One system or process for studying the heritage of technology -- past is the anthropological unit approach to the study of technology. This approach for industrial arts deals with the study of the evolution of technology. It has as its focus the development of background and understandings related to "how we got to where we are today."

The major unit topics are --

1. The development of tools and machines and their contribution to the growth of civilization.
2. The development of power and energy and their contribution to the growth of civilization.
3. The development of communications and transportation and their contribution to the growth of civilization.

The total class selects one of the above major unit topics for study and discussion. The class then identifies sub-topics under the particular major unit topic selected. As an example, the following sub-topics would be identified with the unit on tools and machines.

Tools and Machines

loom	cotton gin
lathe	trebuchet
ballista	windlass
Persian water wheel	printing press
drill	pulley
cannon	catapult
forge	saw
axe	sextant

Each student would pursue a separate item with an investigation into its development and related history. The student builds a working or static model of his/her selected sub-topic. A report is also written with emphases on historial, scientific, and social contributions of the selected sub-topic.

Seminars are held to provide a communication and unifying experience wherein each student discusses and describes the early technological development he/she has studied along with its historical and scientific factors and social contributions. A display of pictures, illustrations, or components may also be developed as a part of each student's work.

If the class had chosen power and energy, the following early developments would be examples of sub-topics.

Power and Energy

Newcomen steam engine	battery
sails	windmill
waterwheel	generator
electric motor	turbine
paddle wheel	cars
treadmill	combustion engine

Technology studies related to communications and transportation may involve such unit sub-topics as --

Communications and
Transportation

semaphore	balloon
wireless	airplane
canoes	sailboats
rafts	street car
printing	writing
telegraph	typewriter

The anthropological unit is a popular and exciting experience that is involved in a comprehensive design for learning.

Major Topics

Tools and Machines

Power and Energy

Communication and Transportation

-- and their contribution to the growth of civilization.

Production

models and/or replicas

reports

displays

Concepts

historical factors

technological innovation

scientific factors

contributions to society

construction and development

linkages - technological

Activities

researching

inquiring

planning

organizing

constructing

presenting

leading

helping

drawing

problem solving

writing

conducting seminars

This evolutionary study of technology has been carried out with considerable success in Industrial Arts programs in the United States and abroad.

The group project or group process is another excellent form of instructional organization that may be used in the study of technology -- past,

present, and future. This form of instructional organization has several important qualities or characteristics.

- It is a group effort on a single constructional endeavor by the total class or in some cases by sub-groups in a given class.
- The group project promotes group planning, group coordination and a great deal of internal cooperation.
- This kind of an activity provides excellent opportunities for individual students to display their resourcefulness and dependability as well as skills in leadership, followership, intra-personal relationships, and creativity.
- The group organization uses the common personnel organization structure as found in business or industry. This could include a board of directors, project director, public relations director, construction director, purchasing director, design director, and a host of other related roles.
- The group project is an educational experience that reaches into the dimensions of life-like reality in the school setting.
- It is an experience that makes effective use of the peer culture relationships which exist at the particular age level.
- The group project has great potential for establishing instructional linkages with the needs of society, the content of the area, the developmental tasks of youth, and the psychology of learning.

Activities in the group project approach include --

organizing	role involvement
planning	problem solving
designing	inter-personal involvement
constructing	communications
creating	inquiring
investigating	decision-making

The study of the heritage of technology past may be studied through an endless number of group projects or group processes. A classic example is the development of a model of a 17th century American village or seaport. Every facet of early colonial life was touched by the heritage of technology whether it be the windlass on the ship, the making of candles, printing of papers and books, building of ships, construction of living or business structures or the arts of agriculture, weaving, pewtering, wheelwrighting, or blacksmithing.

Other such past studies might involve a group project centering around the printing of a colonial newsletter or daily bulletin. This would include the technology of the printing press, paper making, ink production, news sources, type production, binding, type setting, and many more integral components in an exploration of early printing and related technologies in America.

Still other group projects could center around the technology of power generation, systems of transportation, water systems, warfare, and construction. These might deal with the cultures of primitive man, Romans, Greeks, Egyptians, and Babylonians.

Studying the heritage of technology -- present.

This dimension of the discussion involves studies regarding the technology of the present and its projected heritage. There are several systems or forms of instructional organizations that would be appropriate from a general technology emphasis or focus. These would include: research and experimentation, unit approach, group projects, and community involvement.

The unit process is an important form of such study. While the study

of the past used the anthropological unit approach, the present would involve the contemporary unit approach.

Examples of major contemporary unit studies of technology would include:

1. Communications in Everyday Living
2. Contemporary Water Development Systems
3. Contemporary Transportation Systems
4. Contemporary Energy Development Systems
5. Contemporary Communications Systems
6. Contemporary Construction Processes
7. Contemporary Manufacturing or Production Processes
8. Etc.

Each of the above would be developed as a unit of instruction much the same way as the anthropological unit was structured. The only difference is the contemporary nature of the major unit and the sub-topics under the major unit.

As an example, the major unit topic or -- "Communications in Everyday Living" might include the following sub-topics for individual students to pursue.

radar	printing units
sonar	street signal lights
radio	telegraph
television	billboards
satellites	tele-graphics
thermostat	computer graphics
numerical control	computer control
laser communication	books

Group project activities associated with the study of the heritage of technology -- present might include studies and constructions (models or replicas) of such contemporary items as --

transportation terminal	communication systems
sewage treatment plant	housing models
energy producing units	trash disposal processes
-- wind powered	coal extraction
-- water powered	oil extraction
-- solar powered	renewable energy
-- nuclear powered	community planning
-- fossil fuel	water development
-- geo-thermal	hydraulic power
transportation systems	renewable energy sources
pollution control	solar heating models

Each of the above would be dealt with in terms of some form/s of technological fix.

The community involvement model of educational design for the study of technology present and future has some real possibilities that are related to the much-discussed curricular posture of moving the school out into the community and moving the community into the school. The essence of this approach is to identify those problem areas in the community where there is some active pursuit of the problem or to examine problem areas in need but not getting any attention or resolution. Each of these should, of course, lend themselves to technological solution. This is the community problem dimension of the community involvement design for educational experience.

A second community involvement model would use the community as a set-

ting in which the technology - present would be studied at the operating site. This could involve visitations, observations, and sessions at such community units as --

airports and terminals	television stations
transportation centers	city planning centers
water purification centers	construction sites
power generation plants	sewage plants
landfills	museums
fire academies	police academies
manufacturing plants	food processing plants
communication centers	energy processing units

Constructional and design elements of both forms of community involvement instruction would include group and individual projects.

The research and experimentation elements of the study of technology -- present would take on some highly relevant areas of inquiry. The students could pursue actual research in such areas as --

- home (heat and cold) insulation (consumer/energy)
- home (noise or sound) insulation materials (consumer)
- solar energy utilization (energy)
- air resistance studies (energy)
- water resistance studies (energy)
- pollution control devices (pollution)
- wind-vane development (energy)
- water purification (resource development)
- structural component design (consumer/resources)
- product comparisons (consumer/energy)
- process comparisons (production/energy/consumer)

Studying the heritage of technology -- future

The study of the heritage of technology -- future may be studied through a variety of different forms of instructional organization. These could include the unit, group process, community analysis, or individual inquiry instructional procedures.

Since the future is something to be experienced and is that which lies ahead at any given point of time, it might be well to consider what it is about the future that the study of technology -- future should be concerned. The following may provide some direction for the educational design.

1. The individual will be faced with making decisions about technological alternatives to problems and issues.
2. Technology will play an increasing role in the solution of the problems in the future.
3. The design of the future is largely in the hands of humankind.
4. The democratic ideal will require a greater degree of understanding of technology and its potential.
5. The need for adjustment, flexibility, and adaptability on the part of the people.
6. The great emphasis on the ability to learn.
7. There will be a great emphasis on a "sustaining" of resources society rather than on a "depleting" of resources society.

Each of the techniques or instructional procedures listed previously in this section has some role to play in the study of technology with respect to the future.

The study of technological alternatives is very effectively dealt with

in the unit approach where a single problem area is identified and each student takes on a different technological approach to the problem. The following is an example:

Unit topic. The Development and Application of Alternative Energy
Sources in the Solution of Society's Needs in the Future

Sub-topics (Selected by individual students)

solar energy	nuclear fission
wind power	nuclear fusion
artificial gas from waste	plant sources
synthetic fuels	trash utilization
geo-thermal	coal
hydro-electric	shale
chemical	gas
wave (ocean)	thermal-differential

The design of the future is effectively pursued through two different processes previously identified.

a. The group project provides many opportunities for creative experience in developing three-dimensional images of proposed developments with respect to communities or systems in a community.

o Community (examples)

1. Model cities development
2. Community change models
3. Inner city redevelopment

o System Development (examples)

1. Transportations systems
2. Communications systems

3. Energy development systems
 4. Housing and recreational systems
- b. The community involvement instructional process has an exceptional potential for approaching the design of the future with respect to the kind of a community that would appear appropriate. This would take the realities that exist in a given area or community and then have the classes --
1. redesign the community in terms of projected ideals. (Use of models, drawings, schematics).
 2. redevelop certain sections of the given community (Use of models, drawings, schematics).
 3. redesign the transportation system in a given community (Use of models, drawings, schematics, flow charts).
 4. development of pollution control measures for a community.
 5. development of water and waste treatment facilities in the community.

Each of the above categories of instructional design (unit, group project or community involvement) would have a great deal of individual inquiry, and problem solving associated with them. However, if the teacher and the students would elect to pursue such topics on an individual basis, this too could be done. It would be important, however, to provide some systematic procedure for sharing ideas, developments, and outcomes.

It is important to note that the teaching of the heritage of technology -- past, present, and future is much more than dealing with the hardware of technology in given periods. The educational programs should be designed for the development of people capable of living and contributing to the present and the future. This brings into focus the important dimensions of the processes

of education.

The impact of the study of technology with respect to the development of the human component must deal with the processes of learner involvement in systematic inquiring, problem solving, analyzing, synthesizing, and generalizing. The process of learning to learn and the development of the resourcefulness of the individual must be stressed in any rapidly changing society so profoundly affected by an accelerated technology. The processes of education must also strive for the development of the personal qualities of flexibility, adaptability, and mobility.

These people requirements in the 1980's and the century ahead must grow out of the study of technology. The design for learning will be equally or more important than what is to be learned. The systems previously described -- unit studies, group processes, research and experimentation, and the community involvement models are designed around the centrality of the individual in the learning process as well as the human needs to function effectively in the present and future.

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